CLAIMS:

1.   1.   A method of diagnosing pathologic heart conditions comprising:
2   identifying a systolic sub-interval of a systolic interval for a plurality of heart
3   cycles in a sequence of heart cycles;
4   computing an energy value for each systolic sub-interval;
5   computing a composite energy value using the computed energy values for each
6   systolic sub-interval; and
7   comparing the composite energy value to a threshold level in order to distinguish
8   between a normal heart and a pathologic heart.

1.   2.   A method of diagnosing pathologic heart conditions comprising:
2   filtering a time series of heart sounds;
3   parsing the time series of heart sounds into a sequence of individual heart cycles;
4   identifying a systolic interval for each heart cycle;
5   identifying a systolic sub-interval of the systolic interval for each heart cycle;
6   computing an energy value for the systolic sub-interval of one or more heart
7   cycles, said energy value being proportional to the energy level associated with the filtered
8   series of heart sounds;
9   computing a composite energy value for the systolic sub-intervals of one or more
10   heart cycles; and
11   comparing the composite energy value to a threshold level in order to distinguish
12   between a normal heart and a pathologic heart.

1.   3.   The method of claim 2 wherein said parsing step uses electro-cardiogram (ECG)
2   data in order to transform a time series of heart sounds into a sequence of individual heart
3   cycles.

1.   4.   The method of claim 2 wherein said parsing step uses acoustic heart sounds
2   obtained directly from a patient in order to transform a time series of heart sounds into a
3   sequence of individual heart cycles.

1   5.   The method of claim 2 wherein identifying a systolic interval for each heart cycle

2   is achieved by identifying pulses on an electro-cardiogram (ECG).

1   6.   The method of claim 2 wherein identifying a systolic interval for each heart cycle

2   is achieved by acoustically locating a first and a second heart sound using a bandpass

3   filter, said bandpass filter applied to the time series of heart sounds.

1   7.   The method of claim 2 wherein filtering the time series of heart sounds is achieved

2   using a bandpass filter.

1   8.   The method of claim 2 wherein filtering the time series of heart sounds is achieved

2   using time-frequency transforms.

1   9.   The method of claim 8 wherein the time-frequency transform is a wavelet

2   transform.

1   10.   The method of claim 8 wherein the time-frequency transform is a Fourier

2   transform.

1   11.   The method of claim 2 wherein the systolic sub-interval is centered in systole.

1   12.   The method of claim 2 wherein the systolic sub-interval is centered in systole and

2   is half of the systolic interval.

1   13.   The method of claim 2 wherein the composite energy value is computed as the

2   median of the computed energy values for more than one of the systolic sub-intervals of

3   the heart cycles.

1   14.   The method of claim 2 wherein the composite energy value is computed as the

2   weighted average of more than one of the computed energy values for the systolic sub-

3   intervals of the heart cycles.

1   15.   The method of claim 2 wherein the composite energy value is computed as the
2   median across more than one of the heart cycle systolic sub-intervals of a quantity
3   proportional to energy.

1   16.   The method of claim 2 wherein the composite energy value is computed as the
2   weighted average energy value across more than one of the heart cycle systolic sub-
3   intervals.

1   17.   The method of claim 14 wherein the ratio of energies between systolic interval and
2   diastolic interval are also used to distinguish a normal heart from a pathologic heart by
3   prior statistical characterization of the ratio of energies between systolic interval and
4   diastolic interval for normal and pathologic hearts.

1   18.   The method of claim 14 wherein the standard deviation of the energy in a systolic
2   interval is also used to distinguish a normal heart from a pathologic heart by prior
3   statistical characterization of the standard deviation of the energy in a systolic interval for
4   normal and pathologic hearts.

1   19.   A system for diagnosing pathologic heart conditions comprising:
2   a portable computing device for:
3   managing data collection from new patients;
4   storing data; and
5   analyzing data,
6   and
7   a patient data collection unit for acquiring electro-cardiogram (ECG) and heart
8   sound data from a patient, said patient data collection unit operatively connected with said
9   portable computing device.

1   20.   The system of claim 17 wherein the patient data collection unit comprises:
2   a contact microphone for obtaining acoustic data;

3   an acoustic pre-amplifier operatively connected with said contact microphone, said

4   pre-amplifier having a passband of 20 Hz to 2 kHz used to condition acoustic data

5   received from said contact microphone;

6   a variable amplifier operatively connected with said acoustic pre-amplifier for

7   variably amplifying the conditioned acoustic data;

8   an electro-cardiogram (ECG) electrode;

9   an ECG amplifier operatively connected with said electro-cardiogram (ECG)

10 electrode;

11   an analog to digital converter operatively connected with said variable amplifier

12 and said ECG amplifier, said analog to digital converter for digitizing acoustic data and

13 electro-cardiogram (ECG) data.

1   21.   A method of optimizing a heart auscultation screening algorithm comprising:

2   applying a heart auscultation screening time-frequency transform algorithm to a set

3   of data, wherein:

4   said algorithm includes wavelets and bandpass filters;

5   said data includes heart sounds known to be normal and heart sounds known to

6   be pathologic;

7   said heart sounds being characterized by a systolic interval;

8   said systolic interval capable of being divided into systolic sub-intervals,

9   recording the results of said heart auscultation screening algorithm for a variety of

10 time-frequency transform parameters and systolic sub-intervals; and

11   determining an optimal combination of wavelet scale parameter and systolic sub-

12 interval for use with said heart auscultation screening wavelet algorithm based on

13 sensitivity and specificity measurements.

1   22.   A computer readable medium whose contents cause a computer based system to

2   determine patient heart pathology by:

3   identifying a systolic sub-interval of a systolic interval for a plurality of heart

4   cycles in a sequence of heart cycles;

5   computing an energy value for each systolic sub-interval;

6   computing a composite energy value using the computed energy values for each

7   systolic sub-interval; and

8   comparing the composite energy value to a threshold level in order to distinguish

9   between a normal heart and a pathologic heart.

1   23.   A computer readable medium whose contents cause a computer based system to

2   determine patient heart pathology by:

3   filtering a time series of heart sounds;

4   parsing the time series of heart sounds into a sequence of individual heart cycles;

5   identifying a systolic interval for each heart cycle;

6   identifying a systolic sub-interval of the systolic interval for each heart cycle;

7   computing an energy value for the systolic sub-interval of one or more heart

8   cycles, said energy value being proportional to the energy level associated with the filtered

9   series of heart sounds;

10   computing a composite energy value for the systolic sub-intervals of one or more

11   heart cycles; and

12   comparing the composite energy value to a threshold level in order to distinguish

13   between a normal heart and a pathologic heart.

1   24.   A computer readable medium whose contents transform a computer based system

2   into a heart pathology detection system, comprising:

3   a patient data collection subsystem for acquiring electro-cardiogram (ECG) and

4   heart sound data from a patient;

5   a data management subsystem for managing electro-cardiogram (ECG) and heart

6   sound data;

7   a data analysis subsystem for processing and analyzing electro-cardiogram (ECG)

8   and heart sound data; and

9   a data storage subsystem for storing processed electro-cardiogram (ECG) and heart

10   sound data.